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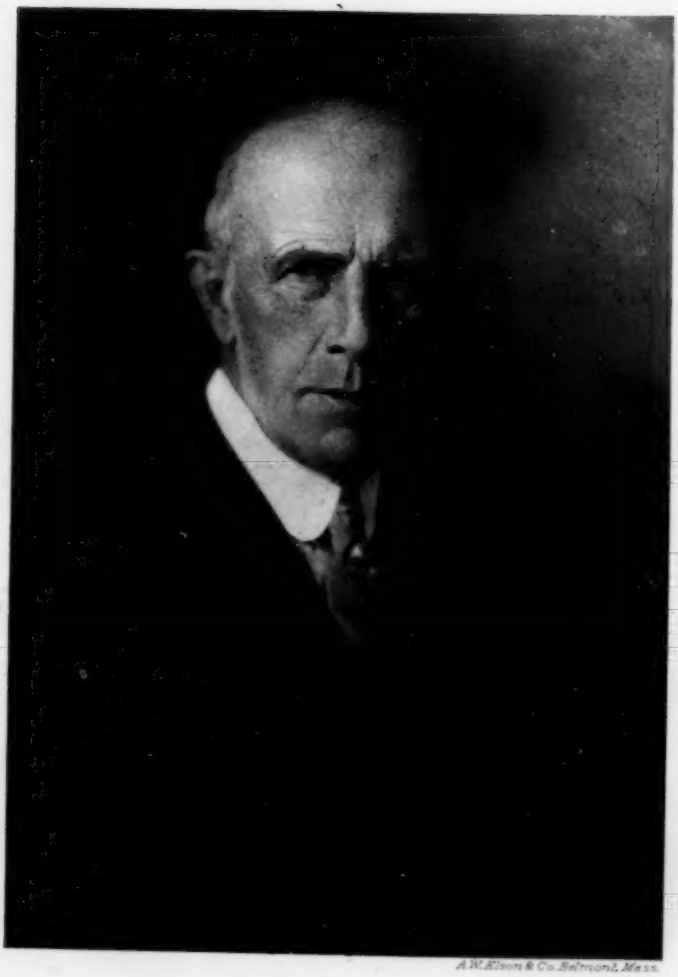

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Ezra Brainerd

(1844–1924)[1]

WILLARD W. EGGLESTON

(WITH PORTRAIT)

In the passing of Ezra Brainerd, we are reminded that he was the outstanding representative in his generation of a distinguished succession of native Vermont botanists. His work furnishes a notable example of how the amateur in science may make important contributions to its advancement.

He was born in St. Albans, Vermont, 17 December 1844, as the eldest son of Lawrence Robbins and Catherine (Wood) Brainerd, and died in Middlebury, Vermont, 8 December 1924. He was of the eighth generation from Daniel Brainerd who settled in Haddam, Connecticut in 1662. His forefather, Deacon Ezra Brainerd of the fourth generation (first of four to bear the name Ezra) who represented the town of Haddam in the General Assembly of Connecticut for thirty-three sessions, is typical of the character of this notable New England family. On his mother's side, he came from an earlier American immigrant, Thomas Wood of Rowley, Massachusetts. His mother's grandparents, Enos and Asenath (Hazen) Wood, were the first settlers of the town of North Hero, Grand Isle County, Vermont, going there in 1783 from Bennington, where Enos Wood, with his elder brother and his father, had fought in the famous battle, the sesquicentennial of which has so recently been celebrated. Major Enos Wood and two of his brothers pushed on into northern New York to become the founders of the town of Malone about 1803. Coming from such pioneer stocks, it is easy to account for his love of the Lake, and his bent for woodcraft and natural history.

[1] From a paper presented before the Vermont Botanical and Bird Clubs, 28 January 1927.

The portrait is from a photograph taken in 1915 by Snow, Boulder, Colorado; it is here reproduced, by the courtesy of Doctor Brainerd's family, from the photogravure plate used for their own *Memorial* published in 1927.

[The BULLETIN for January (55: 1–90) was issued 22 February 1928.]

As a boy he grew up on Lake Champlain, acquiring a love for swimming, fishing, and boating, which remained with him all of his life. His early education was in the public schools of St. Albans. At fifteen, by invitation of the college authorities, he visited Middlebury College and became a member of the Freshman class. Graduating in 1864 at the age of nineteen,[2] at the head of his class, he was immediately made Tutor in Greek. In the fall of that year a heated campaign which resulted in President Lincoln's re-election was taking place. One day President Larrabee met Tutor Brainerd and said: 'Young man, are you going to vote for President?' 'No, Sir.' 'Why not, Sir?' 'I am only nineteen, Sir.' 'What, Sir! an officer in college and not of age?' 'Mr. President, you appointed me, Sir.'

In 1866 he went to Andover Theological Seminary, returning to Middlebury in 1868 as Professor of Rhetoric and English Literature; he was Professor of Physics and Applied Mathematics, 1880–1891, and President of the College, 1885–1908; on his retirement from the presidency he was elected a Trustee; thus he was connected with the College for practically sixty-five years, except for the two years at Andover. With rare ability and many outside opportunities his life was devoted to his Alma Mater. His career is a proof of the versatility of the man.

Shortly after the completion of his Seminary course and his return to Middlebury, Professor Brainerd was married to Frances Viola Rockwell. They began their life together at beautiful old Springside, the Rockwell homestead, which remained Doctor Brainerd's home until his death. His second wife was Mary Wright of Bristol. There were seven daughters and a son, all but one still living.

Doctor Brainerd's broad philosophical mind was fortified by a sturdy common sense that was refreshing. He recognized the tendency among critical students of science to magnify small differences and guarded himself against it. He often referred to the three European hawkweed experts who split species so finely that they could not recognize each others' species. One of the most modest of men, never putting himself forward, Doctor

[2] The degrees conferred upon Dr. Brainerd were A.B., 1864, and A.M., 1867, by Middlebury College; LL.D., 1888, by the University of Vermont and by Ripon College; D.D., 1900, by Howard University; and Sc.D., 1914, by Middlebury.

Brainerd was the last person to think of himself as a great man. No one ever had a better companion and friend, stimulating, interesting, full of fun, still terribly in earnest in his work. The amount of work he did and the real ability that he put into everything that he touched is marvelous. His intensely active mind was always busy. One of his life mottoes was—'Push the work; never let the work push you.'

He became the leading authority on the land lines of Addison County. His knowledge of 'Green Mountain' lots was broad and accurate. The eastern tier of lots in the town of Middlebury puzzled him. A measurement of the eastern line of the town was necessary as a check but this line ran over almost impassible ledges. One favorable winter Professor Brainerd ran a transverse line across Middlebury on the ice of Otter Creek. This measurement showed that the lots on the eastern side of the town had all been occupied one lot south of their proper location. The northern lot was virgin timber while all the other lots had been lumbered. It was on Brainerd's advice that Mr. Joseph Battell began buying spruce lots at seven cents per acre. 'Battell Forest' is now the largest area of virgin forest in the Green Mountains and a fine asset of Middlebury College. Thus in later years Brainerd's expert knowledge of mountain timber lots became of use to Middlebury College.

The writer in his own surveying practice often consulted President Brainerd in regard to Addison County lines. It was a rare pleasure to travel the Ripton woods with him. Once we walked through from Abbey pond to the black spruce bog. The lumbermen had done their worst and it was no small job to find marked lines, but Brainerd, rarely hesitating an instant, followed a lot line, taking a rapid pace to the bog.

Although always deeply interested in his natural surroundings, Professor Brainerd took up scientific studies partially as a method of relaxation from official duties and as a means of getting out of doors. He also gave much time to his flower, fruit and vegetable gardens.

Doctor Brainerd's scientific work can be separated into two periods. The first period covers his early botanical collections and his geological surveys and publications, ending with his last publication on geology in 1896. The second period covers his critical study of plants, with the exception of *Carex*, and the study of their heredity.

Of his geological work, Mr. E. J. Foyles, of the American Museum of Natural History, writes:

> The science of geology in Vermont owes much to Professor Brainerd. His six papers on the geology of the state include a series of maps constructed with much care and accuracy. The favorable exposure of the lower Ordovician rocks in the Champlain Valley led him to essay a painstaking description of their character and fossil contents. The keen observation, criticism and analysis which this work involved is evident in the earnest and impartial sentences of his papers. . . . His dependable work has endured for many years and is the constant reference of teachers and students of Champlain Valley geology.

Doctor Brainerd's interest in botany began in early life. His first botanical text book was Wood's *Class-Book of Botany* of 1861. The earliest date observed in his herbarium is found on a sheet of *Diapensia* collected at Mt. Mansfield, June 16, 1868. The then little-known *Polystichum Braunii* he collected at Barley Falls, Hancock, the following August. These two sheets indicate an exceptionally intelligent interest in plants as early as his twenty-fourth year.

In November, 1873, the BULLETIN OF THE TORREY BOTANICAL CLUB published a 'Botanical Directory for North America and the West Indies,' in which were listed eight Vermont botanists, including C. G. Pringle of Charlotte, Prof. George H. Perkins of Burlington, Charles C. Frost and Mrs. Ann E. Brown of Brattleboro, Dr. E. E. Phelps of Windsor and Dartmouth College, Dr. Hiram A. Cutting of Lunenberg, M. L. Herrick of Rutland, and Prof. Brainerd of Middlebury College. In the Directory of 1878 Professor Brainerd is listed for exchanges.

Doctor Brainerd's herbarium shows an occasional plant before 1877, but from 1877 to 1879, and later, it rapidly expanded both from his own collections and by exchange. Brainerd's specimens, even the early ones, are admirably selected and preserved and artistically mounted. Naturally his exchanges show equal care in the selection of his correspondents. The botanical work of Brainerd and of Pringle at this time is a marked example of fine team work. Both were superior collectors, but Brainerd was influenced by the example of Pringle's classical specimens, while Brainerd's keen analytical mind was of service in the determination of Pringle's critical species. Brainerd's intimate knowledge of Pringle and his work enabled him to secure the

advancement of Pringle to official Collector for Harvard University after Dr. B. L. Robinson became Curator of the Gray Herbarium. Brainerd's sketch of Doctor Pringle in *Rhodora* after his death was from the heart.

In these early years Brainerd's principal scientific interest was in geological work. However, these field studies presented an excellent opportunity to collect plants over a wide range of territory.

His first scientific publication, 'New Finds for New England,' was a note in the BULLETIN of the Torrey Club in 1881, recording new stations for *Polemonium caeruleum* L. and several other species new to Vermont.

His first geological paper came out in 1885, and his last one in 1896. This period coincides with his early work as president of Middlebury College and has some bearing on his changing interest from geology to botany. A dominant incentive to this change came with the organization of the Vermont Botanical Club in 1895, with its subsequent regular meetings, largely devoted to explorations or discussions of the Vermont Flora, in all of which he was keenly interested.

Brainerd's critical work in plants began in the genus *Carex*. Whenever Pringle returned from the field, all sedges and ferns were passed over to Brainerd for study. Brainerd's only publications on *Carex* were in the two editions of the *Flora of Vermont*. However, he kept in close touch with the *Carex* specialists, Professor L. H. Bailey, Professor M. L. Fernald, and Mr. K. K. Mackenzie. The latter had Brainerd's *Carex* herbarium for study during several years, and all three botanists freely exchanged with Brainerd. On his first trip to California, in 1897, President Brainerd made a large collection of sedges in the Sierra Nevada Mountains and in the mountains along the Canadian Pacific in British Columbia. On this trip his old college chum, Mr. R. N. Donaldson, General Passenger Agent for the Southern Pacific lines, contributed much to the ease and success of the occasion by extending to Brainerd all of the facilities of both the Southern Pacific and the Canadian Pacific railways. Sedges were always searched for on his numerous journeys about the New England States and on the long journeys South. Several trips were made to eastern Quebec to study hybrid sedges. Mr. Mackenzie writes in regard to the Brainerd *Carex* herbarium:

I would say that his collection of *Carex* was especially noticeable for the very fine character of the materials he had collected. He always got adequate material in mature condition which fully represented the species. He rarely had very many sheets of any species but in the aggregate he had a great number of species very largely collected by himself. The most valuable collections he ever made were those in the Sierra Nevadas of California. These collections have formed the basis for several new species.

Among these new species was *Carex Brainerdii* Mackenzie.

But it was in the second period that his great work in botany and evolution was accomplished. The studies of the previous period were valuable training for his greatest contribution to science. His surveys and studies in geology, his widening knowledge of the plants of the country, and his contacts with the other naturalists of his generation were now to bear fruit.

The early work in North American descriptive botany had been done by Europeans. Fortunately, while the West was being explored, three great American botanists, John Torrey, Asa Gray, and George Engelmann, were prepared to write descriptions of the multitude of newly discovered plants. Their influence in many ways was sound, but it became strongly conservative. The death of Doctor Gray in 1888 left no one to dictate authoritatively in American descriptive botany. In California was a former eastern man, Dr. Edward Lee Greene, who had served in Grant's Army in the Civil War, and as a missionary had botanized over much of the West. He began describing western plants in 1880. In 1895 Doctor Greene came to Washington, and soon began describing eastern violets and other plants. In 1879 Columbia University graduated Dr. N. L. Britton, who soon became a leader in the revision of American plants. His *Illustrated Flora* (Britton & Brown, 1896–1898) was published while the first Vermont flora was being prepared. Professor M. L. Fernald came to Harvard University in 1891. His explorations and studies with those of Dr. B. L. Robinson were materially to change *Gray's Manual of Botany* in its seventh edition in 1908.

In the revision of the eastern botany Doctor Brainerd[3] and other members of the Vermont Botanical Club did their full share by keeping the specialists busy on Vermont plants.

[3] Dr. Brainerd printed a list of the plants of the Middlebury region, but had no copy left in 1892. I have never seen the list. Does anyone have a copy?

Vermont enjoys the distinction of a large and interesting flora. The first published catalogue relating to Vermont plants, *Catalogue of plants indigenous in the town of Middlebury, Vermont*, 1821, by Dr. Edwin James, of the class of 1816, was partially prepared while he was a student in college. Most of the early collecting in Vermont was done by men visiting the state. The first state list, *Catalogue of the Plants of Vermont*, was prepared by William Oakes of Massachusetts and published by Thompson in 1842, and is a classic among early plant lists of the country Dr. G. H. Perkins published *A General Catalogue of the Flora of Vermont* in 1882, and revised it in 1888. Beginning in the seventies, botanical explorations of Vermont were largely in the hands of Vermonters, although men like Jesup, Congdon, the Faxons, and Kennedy were doing fine collecting in Vermont. In this work Perkins, Pringle, Brainerd, Ferdinand Blanchard, and W. H. Blanchard were worthy followers of James, Bigelow, the Bootts, Thompson, Robbins, Macrae, Oakes, Carey, Joseph Torrey, Tuckerman, Wood, and Frost. In 1891 when the writer returned from Dartmouth College, the active workers in Vermont botany were few, but the state was soon to see a marked increase in botanists. In February, 1895, Perkins' *Flora* was nearly out of print. Professor L. R. Jones, A. J. Grout, and the writer, after conferring with Professor Perkins and President Brainerd, decided to publish a new Vermont flora.

July 4, 1895, six Vermont botanists[4] met at Grout Mills, Stratton. They were there to explore the Torrey Meadows, *become better acquainted with Doctor Brainerd*, and to talk over the organization of a botanical club. Brainerd was appointed chairman of the committee on organization, and at the September meeting in Burlington was elected president, holding the office during the remainder of his life. The Club soon had more than 100 members. President Brainerd was now prepared to lead, and his expert leadership wrought results in American botany of this period.

Brainerd became interested in the blackberries and sent a set to Professor L. H. Bailey. Brainerd's first study of this group was published in *Rhodora*, January, 1900, as 'Blackberries of New England.' In the *Flora of Vermont*, December, 1900, the

[4] They were Ezra Brainerd, L. R. Jones, J. A. Bates, A. J. Grout, M. A. Howe, and W. W. Eggleston.

Vermont species were treated. Soon after this Mr. W. H. Blanchard became interested in the blackberries and published many species. Doctor Brainerd kept in close touch with Blanchard's and other publications on the blackberries, but wrote nothing further until his paper 'The Blackberries of Vermont,' presented at the winter meeting of the Vermont Botanical Club in 1914, and published in the Club's *Bulletin* the following April. This paper interested Dr. G. P. Burns and Dr. A. K. Peitersen of the Vermont State Experiment Station, and started the cultural experiments by Peitersen under Brainerd's supervision. In June, 1920, the Vermont Agricultural Experiment Station published Bulletin 217, *Blackberries of New England—Their Classification*, by Ezra Brainerd and A. K. Peitersen; in March, 1921, Bulletin 218, *Blackberries of New England—Genetic Status of the Plants*, by A. K. Peitersen.

In 1899, while final study for the *Flora of Vermont* was being made, it was found that adequate knowledge of the thorn apples (*Crataegus*) was lacking. Perkins' *Flora* listed three species and a variety. One afternoon in May the writer visited Twin Mountains, West Rutland, and collected five species in flower. On arriving home a letter from President Brainerd was found which enclosed one from Fred H. Horsford of Charlotte, Vt. Dr. C. S. Sargent, of the Arnold Arboretum, had asked Mr. Horsford to collect *Crataegus* for him, and Horsford had sent him several new forms, including *Crataegus Crus-galli*, of Perkins' *Flora*, a form not seen from Vermont before, and also the new *Crataegus Pringlei*. Brainerd collected and studied *Crataegus* from the region of Montreal south to the Berkshire Hills, Massachusetts, making several trips with Doctor Sargent. Owing to Brainerd's interest our Vermont material was among the first *Crataegus* species described by Sargent. On Brainerd's advice the writer began his study of the thorn apples.

Beginning in 1899, sets of Vermont violets were sent to Dr. E. L. Greene, who described several new species from this material. Greene's treatment of violets led Brainerd to more field study of the group. He soon found that very little accurate knowledge of violets in their midsummer aspect had been recorded in the manuals. Becoming more and more interested in the problem, he visited the neighboring states and Canada and, beginning in 1904, published twenty-five papers on violets,

principally in *Rhodora* and the BULLETIN OF THE TORREY CLUB. In addition, he prepared the treatment of *Viola* for *Gray's New Manual*, 1908, and Britton and Brown's *Illustrated Flora*, 2d edition, 1913. Southern fields were now beckoning, for the real story of the violets of the South had never been written. A series of spring trips to the South were begun in March, 1907, which continued to 1914. The result of these studies appears in various numbers of the TORREY BULLETIN, in the second edition of Small's *Flora of the Southeastern United States*, and Bailey's *Standard Cyclopedia of Horticulture*. Rocky Mountain and Plains violets were treated in Rydberg's *Flora of the Rocky Mountains*, in 1917. With the violets of the Pacific slope calling him, and three daughters established in California's university city, Doctor Brainerd and his wife visited Berkeley in 1915. His daughter Viola (Mrs. Dudley Baird) always interested in plants, had been searching for violets. She became his companion in his California rambles. He spent a delightful summer and secured an abundance of violets from Humboldt County, south to Los Angeles. He met the California botanists at the meeting of the American Association for the Advancement of Science and studied the California herbaria.

Dr. Brainerd's first discussion of violets, other than with members of the Vermont Botanical Club, was before the New England Botanical Club in January, 1903. In his first publication on the acaulescent violets in *Rhodora*, January, 1904, he made this significant ending to his article:

> But I fancy that more than one of the many new species recently proposed, based on plants from a single station, seen only in petaliferous flower, may prove on more extended observations to be hybrids. This inter-breeding may indeed be more extensive than we have supposed, and may be one of the causes of the perplexity that has attended the study of these interesting plants.

After another summer's field work he published his first paper on violet hybrids. In this article he first used the checkered triangle to arrange the hybrids in mathematical order. His mathematical handling of species was assailed and his triangle laughed at. Now, both mathematics and triangle are in common use by students of genetics.

His beginning in hybrids was with the sedges. He became much interested in the crosses of that genus. At one time Brainerd planted several species of columbines in his garden.

A few years later several new forms of columbine had appeared from seedlings which could be accounted for only as hybrids. Seeing hybrids forming in both the garden and the wild prepared Brainerd in 1900 for the great interest in plant breeding and hybridization aroused by the discovery of the writings of Abbot Gregor Mendel. The blackberries had interested him, and he had several species in his garden. However, cultivating and crossing the few Vermont blackberries required much garden space, careful guarding at flowering time, and much expense. This investigation was later taken up under Brainerd's direction by the Vermont Agricultural Experiment Station. In the violets Brainerd found the ideal plant for his hybrid investigation. Although perennial plants, they start as seedlings in the spring, producing both petaliferous and cleistogamous flowers and seeds in one summer. The cleistogamous flowers needed no guarding from insects, since these flowers are closed and insects can not reach the pollen. Hand pollination in violets presents difficulties for amateur or professional, and Brainerd did not attempt this himself. Instead he began the problem at the other end by using seeds of the closed flowers of violet hybrids. Seedlings from these hybrid plants split into several forms between the parent species, and the demonstration was accomplished. Mr. Gershoy of the Vermont Experiment Station has since succeeded in checking up the violet hybrids by hand pollination. In his garden Brainerd had violets from more than one hundred correspondents. One correspondent sent violets from twenty-six states. Brainerd, himself, collected violets in twenty-three states and several Canadian provinces.

On his return from the California journey in 1915, Brainerd studied the Pacific Coast plants, made most of his final selections of species and was ready for his monograph, but the necessary funds were unavailable. It was well that Brainerd could make his final judgments while in fine physical and mental condition, for he was over seventy years of age and was to undergo a serious surgical operation and a nearly fatal illness before his violet bulletins could be begun. His remarkable skill in systematizing and recording his work was now to bring returns, for without his accurate notes and records and his fine collection of dried violets the violet bulletins might never have been written.

The violet investigations had all been accomplished at his

own expense, but financial aid was needed for the final publication. In the fall of 1920 the publication was assumed by the Vermont Experiment Station. Vermonters may well take pride in the fact that his work was published by their own state. Dr. G. P. Burns, botanist at the station, selected twenty-five species to be illustrated in color (from the water-color drawings of F. Schuyler Matthews) leaving fifty to be illustrated by line drawings, and Brainerd went to work on the Violet Bulletin. It was completed after a year, in spite of serious difficulties arising from his own physical condition, and the illness and passing of Mrs. Brainerd at the time Bulletin No. 224 was being finished. Returning health allowed him more interest in his violets, and occasionally plants were tried out in his garden. Again at the request of Vermont Experiment Station the hybrid violets were taken up, and appeared as Bulletin No. 239, late in 1924. Copies of this bulletin were received a few days before Doctor Brainerd's death. On a visit to him in September, 1924, shortly after the preparation of the last violet bulletin was finished, he was found in excellent health and spirits, planning his History of Middlebury College.

In Brainerd, Vermont raised one of her greatest sons. His sixty year labors at Middlebury College and his lifelong studies in natural science are his imperishable monuments.

Dr. Liberty Hyde Bailey pays this tribute to Dr. Brainerd:—

> Unfortunately, I did not know Dr. Brainerd personally, but had corresponded with him and exchanged material for many years, knew intimate friends of his, and have always followed his botanical writings; in all these associations I greatly admired him. I hope his memory and his work will be actively perpetuated in his native State.

Professor M. L. Fernald of the Gray Herbarium writes as follows:—

> Dr. Brainerd was constantly sending specimens of technical groups here and in studying one problem or another in the flora of the Northeast. I frequently cited his specimens and was encouraged by him in the publication of many species and varieties. . . . The only species I have published, which was based chiefly upon Brainerd's material, was *Antennaria Brainerdii*.

Dr. John Hendley Barnhart says of his work:[5]

> His conclusions have been very generally accepted by botanists; it is not often given to an amateur, busy with other things, to make so sound and solid an addition to knowledge.

[5] American Fern Journal **15**: 128.

A well-known botanist of the Continent writes that he regards Doctor Brainerd's work on *Rubus* and *Viola* as 'the only field-work of this generation that is of any real value in the study of evolution.' [6]

Professor Charles B. Wright in his exquisite tribute delivered at Middlebury College Commencement, June, 1925, has this to say:[6]

> First of all, he was a scholar; he acquired knowledge easily, and retained it seemingly without effort. I have seen him take a book from beneath a student's arm, and, opening it at random, translate a page of Greek, verse or prose with no hesitation and in the most idiomatic of English—though he had been in no direct touch with Greek since his seminary days. The scope and accuracy of his learning, too, were at once one's admiration and despair. In geology, his demonstrations of the thickness of early strata—demonstrations furthered by his skill as a surveyor—made revision of the text-books a necessity. His contributions to botany are internationally authoritative. He knew this region, not only its physical features, but the metes and bounds of its early ownership, as no one else has known it. And with it all he knew Tennyson and Shakespeare as few others I have ever met have known them, and his thought and its expression bore evidence often of that loving familiarity.
>
> He was, moreover, a teacher,—which all great scholars are not,—grasping and imparting essentials with a rare lucidity. . . .
>
> The years that followed his retirement were busy, productive years, and the reward they brought was a continuance, to the last, of that wonderful mental vigor. The conclusions reached in his studies still win the praise of scholars; his talk, for those who were privileged to listen, had the old-time interest and charm. The programme he had set for himself was one that could have no end; and how much was left, in the work unreached, that no one now can do.
>
> The unfinished window in Aladdin's tower
> Unfinished must remain!

Scientific papers of Doctor Brainerd

New finds for New England. Bull. Torrey Club **8:** 6. Ja 1881.

The marble border of western New England. Introductory (with P. Battell and R. Wainwright). The geological features of the marble belt. Papers and Proc. Middlebury Hist. Soc. **1**[2]: i–vi, 9–21. *maps.* 1885.

The original Chazy rocks (with H. M. Seely). Amer. Geol. **2:** 323–330. 1888.

The calciferous formation in the Champlain Valley (with H. M. Seely). Bull. Geol. Soc. Amer. **1:** 501–511. 29 Ap 1890.

The calciferous formation in the Champlain Valley (with H. M. Seely). Bull. Amer. Mus. Nat. Hist. **3:** 1–23. *f. 1–9 + maps 1–5.* My 1890.

The Chazy formation in the Champlain Valley. Bull. Geol. Soc. Amer. **2:** 293–300. *pl. 2.* 17 Mr. 1891.

The Chazy of Lake Champlain (with H. M. Seely). Bull. Amer. Mus. Nat. Hist. **8:** 305–315. *maps.* D 1896.

[6] A Memorial of Ezra Brainerd. [Published by his family, 1927.]

Progress in our knowledge of the flora of Vermont. [Paper presented at the winter meeting of the Vermont Botanical Club, 1897; not published, but filed with the Club library.]

The Saniculas of western Vermont. Rhodora **1:** 7–9. 2 Ja 1899.

Hydrastis canadensis in Vermont. Rhodora **1:** 200. 4 N 1899.

Typical *Goodyera repens* in New England. Rhodora **2:** 22. 2 Ja 1900.

The blackberries of New England. Rhodora **2:** 23–29. 7 F 1900.

Flora of Vermont (with L. R. Jones and W. W. Eggleston). Published as an appendix to the 20th Vermont Agricultural Report, and separately with the same pagination as: Contributions to the Botany of Vermont **8:** i–xii, 1–113. 15 D 1900.

Scirpus atratus a synonym of *Scirpus Peckii*. Rhodora **3:** 31–33. 1 F 1901.

The plants of Vermont. Vermonter **5:** 85–97. Mr 1901. [*portrait of Ezra Brainerd.*]

Two more rare plants from Lake St. John, Quebec. Rhodora **4:** 128–129. 14 Je 1902.

Notes on New England violets. Rhodora **6:** 8–17. *pl. 50.* 30 Ja 1904.

Addenda to the Flora of Vermont, by W. W. Eggleston (revised, as to nomenclature, by E. Brainerd). Rhodora **6:** 137–144. 15 Je 1904.

Hybridism in the genus *Viola*. Rhodora **6:** 213–223. *pl. 58.* 30 N 1904.

Scirpus validus and allies in the Champlain Valley. Rhodora **6:** 231–232. 16 D 1904.

Notes on the New England violets,—II. Rhodora **7:** 1–8. 26 Ja 1905.

The use of accentual marks in Gray's Manual. Rhodora **7:** 189–190. 29 N 1905.

Notes on New England violets,—III. Rhodora **7:** 245–248. 31 D 1905.

Hybridism in the genus *Viola*,—II. Rhodora **8:** 6–10. 7 F 1906.

Nephrodium Filix-mas in Vermont. Rhodora **8:** 22–23. 7 F 1906.

Hybridism in the genus Viola,—III. Rhodora **8:** 49–61. *pl. 66–70.* 27 Mr 1906.

How stems and stolons disappear in *Viola*. Bull. Vermont Bot. Club **1:** 11. Ap 1906.

A visit to the grave of Thomas Walter. Bull. Charleston Mus. 3: 33–37. Ap 1907.

The behavior of the seedlings of certain violet hybrids. Science **25:** 940–944. 14 Je 1907.

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Dr. Brainerd's letter file contains all of the letters he received.

The Gray Herbarium Library has the complete file of his letters beginning in March, 1892.

Eggleston's letter file contains Brainerd's letters from the beginning of his correspondence in January, 1892.

Brainerd's herbarium contains about 10,000 sheets representing 5,000 species. The Gray's Manual region is well represented. The most valuable part of the collection is *Viola*, *Carex*, and the ferns, including Pringle's Mexican ferns.

Microsporogenesis in Tropaeolum majus with special reference to the cleavage process in tetrad formation

ALTA BOLENBAUGH

(WITH PLATES 6, 7)

In the study of meiosis in various plants, several writers have found and discussed the furrowing process which takes place in the formation of the pollen tetrad, and although this process has been mentioned in *Tropaeolum*, nothing very definite has been set down concerning this particular plant. The present study was for the purpose of verifying some of the observations, and for further investigation into the quadripartition process in tetrad formation.

HISTORICAL

Several authors seem to agree that in most cases dicotyledons form their microspores by quadripartition, but there have been many differences of opinion as to the details of the process. Strasburger (29) in his work on *Tropaeolum*, maintained that cell division was brought about by cell plates, which joined the mother cell wall at points midway between the nuclei. Sachs (24) had earlier reported that quadripartition was brought about by the ingrowth of the mother cell wall at its junction with the cell plates. Most of the later writers find that even if cell plates are present, they have nothing to do with the forming of the plasma membranes.

Miss Pace showed quadripartition in *Parnassia* with the growing-in of the thick mother wall, but mentioned no cell plates. Miss Digby (7) and Cannon (3) both discussed constriction and presented drawings, but did not state whether or not cell plates were formed. Gates (16) found a few ephemeral cell plates, but said they did not function. Castetter (5) found in *Cucurbita maxima* that the cell plates did not extend beyond the limits of the connecting fibers, remained for a short time and disappeared, never having reached the plasma membrane. Others who indicated no cell plates in their discussions of quadripartition are Shoemaker (26) in *Hamamelis virginiana*, Fraser (14) in *Vicia Faba* and Beer (2) in *Crepis*.

Farr (10) found in *Magnolia* that the cell plate and furrows

were both initiated, but the plate disappeared. The furrows began as sharp cutting edges, formed by the folding of the plasma membrane. Some appeared as minute mucronations, some as broad invaginations, some with sharp and others with rounded edges. He noticed that this knife-like furrow gradually deepened and broadened at the base.

Cannon (3) explains that 'indentations appear in the periphery of the cytoplasm and midway between the nuclei, which deepen into constrictions, and finally accomplish the separation of the nuclei and the formation of the tetrads.' He says that no cell wall is organized until the tetrads are formed. A colorless substance and later a delicate membrane are evidently produced by secretion, and when tested give the reaction for cellulose. Kirkwood (20) found in Cucurbitaceae that the division of the cytoplasm took place by constriction. A narrow groove, which marked off the line of division, deepened until the spores were completely separated. He showed the formation of the tetrad in his figure 31, but made no explanation of furrowing. Weinstein (31) reported for *Phaseolus vulgaris* that the division of the cell began by a pinching-in of the cytoplasm, followed by the gradual diminution in density of the cytoplasm along the path of cleavage. Thick partition walls, which he believed to be continuations of the mother cell wall, are formed, and the young microspores are surrounded by a homogeneous substance. This disintegrated rapidly as the pollen grain wall was formed. He reported that Gates found furrowing, not beginning by an active invagination of the cytoplasm, but by deposition of wall material. This was later supplemented by active furrowing on the part of the cytoplasm. He noticed in these furrows delicate cell walls, which could be seen only by special wall stains.

Gates and Rees (16) in speaking of *Lactuca*, stated that the interval between the cytoplasm and the mother cell wall seemed to be filled with a pale staining material, but gave no explanation of it. They found constrictions of the cytoplasm, which became progressively deeper until they met in the center, and cut the cytoplasm into four masses. This method is much like that found by Farr (9) in *Nicotiana* and by Mrs. Farr (13) in *Cobaea scandens*. Louise Nichols (23) showed three drawings of *Sarracenia*, which she labeled completion of the cell divisions

and formation of cell walls. The only explanation given was, 'The cytoplasm, which has remained undivided, now constricts and the four cells of the tetrad are formed.'

The explanation of Castetter (4, 5) for *Cucurbita* and *Melilotus alba* was that quadripartition was brought about by partition walls which originated on the inner surface of the special wall, and grew in between the microspores, by depositing callose on their inner edges. A system of vacuoles was found in *Melilotus*, and the furrows cut through them. As the young pollen grains form their own cell walls, both the mother cell wall and the special wall break down and disappear.

Sugiura (29) in his discussion of *Tropaeolum majus*, said that pollen mother cell division was brought about by furrowing. Protuberances appeared at the periphery of the protoplast and proceeded inward, finally dividing the cell into four spores.

METHODS USED

Material was collected from plants grown in the open during the summer of 1925. The young buds were gathered when they were about three to five millimeters in length, fixed at once in chrom-osmic-acetic acid for thirty-six hours, then washed thoroughly for about twenty-four hours. The buds were embedded in paraffin, and cut five microns in thickness. This was much thinner than the sections used by Sugiura (30), but my results seemed to be better when I used the thinner sections. The sections were stained with the analin safranin, gentian violet and orange G.

OBSERVATIONS AND DISCUSSION

In the early stages the pollen mother cells are packed closely together, with cytoplasm of rather uniform network. The nucleus shows a large, single nucleolus, lying in a more or less central position, and surrounded by thin fibers or threads of linin on which were found quite a number of chromatin granules (fig. 1). This stage corresponds to Sugiura's drawing number 2. A very early stage shows the contents of the nucleus rather dense, but having a few darker granules.

At the beginning of the first contraction, the cells are polygonal in shape, being five-sided in section for the most part. Soon, however, there are signs of rounding off, and the nucleus

becomes larger (fig. 2). I did not notice the partial disappearance of the nuclear membrane as explained by Gates (15) for *Oenothera*, but it seems to be a common thing for the nuclear contents to mass together in an impenetrable form, at one side of the nucleus. My observation agrees with that of Fraser (14) that the mass closes in about the nucleolus, and that the latter is sometimes squeezed out and lies at the periphery of the nuclear cavity. I found also, as Mottier (21) did in *Podophyllum*, that sometimes a few shreds of linin and chromatin project from the tight synaptic knot, although as a rule no structure can be made out.

As the anther grows the cells come to lie farther apart, and apparently secrete their own mother cell walls. These walls do not stain very well with the ordinary triple stain. If the section is stained very dark in the gentian violet, and the orange G is allowed to work a longer time, the thin wall is stained a light brown. Under these conditions, however, the contents of the cell are stained too dense for study.

In the loosening up process the loops of the spireme are thrown out into the cavity, finally taking up most of the space (figs. 3, 4). The spireme contracts and becomes thicker, somewhat granular and rough on the edges, rather than a straight smooth cord. I found the spireme somewhat thicker than that represented by Sugiura, and believe that his drawings 12–18 are different aspects of the same thing rather than different stages. I did not find the loose ends of the threads as he has shown them in his figures 11, 13, and 14, and am inclined to believe that the spireme is an endless thread.

Beer (2) tells us that the second contraction stage is regarded by Farmer and Moore, Lewis, Miss Digby, and Fraser as important in the development of bivalent chromosomes. He says that the loops are actually the bivalent chromosomes of the first division, and that they are constituted of two univalent chromosomes joined end to end. Mottier in *Podophyllum* found that bivalents were formed by the approximation of two parts of the spireme that were arranged end to end in the thread, and not by sister segments that first separated laterally and then came together again or united at one end to form loops or links. Sugiura explains that for *Tropaeolum* each paired ring consists of two univalent chromosomes united end to end, and that the conjugation seems to have occurred telosyndetically.

In the segmented stage the brightly stained nucleolus is found at one side of the nuclear cavity. The chromatin masses are irregular, with pieces varying in size and shape, and lying near the nuclear membrane. Fibers can be seen projecting out from some of the pieces (fig. 6).

The chromosomes have been end to end in the spireme. They break apart and the halves of the bivalents may be thicker than the spireme from which they were formed. Mottier (22) found this true in *Acer negundo*, and says it is probably due to a shortening which always follows soon after complete segmentation. The chromosomes are short, curved, or sausage-shaped, and very small in *Tropaeolum*. A number of them form closed rings. Sometimes no opening can be seen, each member of the bivalent appearing as a little lump. Sometimes the two univalents lie closely side by side, and in this position they appear as one mass. If they were a little longer, they would appear as they do in the lily, but it is not often that we find them as elongated rods in this plant.

When densely stained the bivalents are seen to be connected frequently by delicate threads. The nucleolus and nuclear membrane show definitely in this stage, but disappear as the chromosomes are arranging themselves on the spindle. It seems that these steps take place quite rapidly, as one loculus may show two or three stages.

As the bivalents take their places on the heterotypic spindle, they become much shorter, generally contracting into small lumps with no opening between the two members. The members of the bivalent now separate, one going to each pole. While on their way to the pole, each splits longitudinally. The chromosomes are so small in *Tropaeolum* that the longitudinal split is seen only in exceptional cases, but when they arrive at the poles the process has been completed. The first mitosis is consequently a reduction division, one-half the somatic chromosomes going to one daughter cell, and the other half to the other. The polar view of the metaphase showed the number of chromosomes to be fourteen, as reported by Sugiura (fig. 9). The spindle fibers, which were definitely arranged during the first division, fade away very rapidly.

At first the chromosomes are somewhat massed together, but soon separate, a nucleolus makes its appearance and a nuclear

membrane is formed (fig. 10). Beer (2) in his study of *Tragopogon* and *Crepis*, found that the chromosomes were at first massed, then separated and the nuclear membrane was formed. He thought that the appearance suggested an unstained fluid collecting between and around the chromosomes, which pushed the bodies apart. His theory was that the chromosomes secreted this fluid, and where it met the cytoplasm a precipitation membrane, which constituted the nuclear membrane, was deposited. He thought this viscous substance remained attached to the chromosomes at certain points, and the material became drawn out into connecting bars and arms, which became longer and finer as the chromosomes moved farther apart.

In the homoeotypic division the two spindles arrange themselves parallel to each other in the same plane (fig. 13), or in two planes at right or acute angles to each other (fig. 12). The homoeotypic divisions appear to be swiftly accomplished, as is usual for most plants. The daughter nuclei divide simultaneously, and the four grand-daughter nuclei, which are all alike, are formed in the same way as was observed in the first mitosis. The four nuclei arrange themselves tetrahedrally near the periphery of the mother cell, and fibers connecting them are often visible, but soon fade away (fig. 16).

The same thing was true of the cell plates which I found in a few of the cells (figs. 10, 16). The question of the presence of cell plates and their importance has been brought up in all the discussions of *Tropaeolum* and in many other plants having quadripartition, and the writers are divided in their opinions. Farr (9) made a study of the literature and reports Strasburger as convinced that the division was by cell plates. Sachs (24) had said that cell division was by cell plates and furrowing. Farr, after studying the drawings by Strasburger, interprets them as revealing apparent swellings of the spindle fibers at the equator, but he was not sure that they were cell plates, and said that the quadripartition was by furrowing alone. I found several cases in which cell plates were formed, but as they apparently fade away in a very short time, I do not think they have anything to do with the division of the cell. Ephemeral cell plates have been found in other plants by Gates (15) Castetter (5) and Farr (9), but in all such cases they felt that the cell plates did not function as cell plates usually do.

The first indication of cell division is a slight depression or pinching in of the cytoplasm at four points on the periphery and within the mother cell wall, midway between the daughter nuclei. This generally does not take place until some time after the four nuclei are well formed, although I found cases in which the process began during the telophase of the homoeotypic division (fig. 15).

The furrowing progresses from the outside toward the center in broad hour-glass-like furrows, and finally cuts up the cytoplasm into four separate masses. During the division process the nuclei move away from the plasma membrane, until at the end of the division, they occupy central positions in the daughter cells. The furrows as represented by Sugiura in his figure 44 are much too sharp for this particular plant. He says concerning it,

> The first trace of wall formation consists in slight protuberances appearing at the periphery of the protoplast, midway between two nuclei. They proceed inward (centripetally) rather rapidly and finally divide the cell into four spores.

In speaking of the mother cell wall Sachs (24) says,

> Ingrowths begin to be formed at points which correspond to the superficial ends of the six cell plates. Their growth does not, however, proceed so as to cause the constriction of the protoplasm into four masses; it is soon arrested; the cell walls are formed simultaneously in the six cell plates and are attached externally to the ingrowths of the cell wall of the mother cell. Later each mass of protoplasm forms a new proper wall around itself, which is the wall of the pollen grain; the thick cell walls surrounding them are absorbed, and the four pollen grains are set free.

My observations do not support the statements concerning the ingrowth of the mother wall or the special wall. By staining alcoholic sections with aniline blue as suggested by Strasburger (28), it was found that a special callose wall was formed around the tetrad, but that it did not grow in between the spores as was reported by Castetter (4) in *Melilotus alba*. I verified his conclusion concerning the latter, by using the special stain. I did find in *Tropaeolum*, a pale staining material as described by Gates and Rees (16), but it did not prove to be callose. It is probably dissolved tapetum material, which furnishes food for the young pollen grains (fig. 19).

As each granddaughter cell forms its own cell wall, the special wall and the original mother cell wall break down, and

the one-celled pollen grains become separated (fig. 20). As they mature the cell divides and we have two-celled pollen spores.

SUMMARY

1. Each bivalent chromosome consists generally of a contracted ring formed by two univalent chromosomes that were united end to end in the spireme.

2. Chromosomes shorten and thicken into curved or sausage-shaped masses, as they take their places on the spindle.

3. The haploid number of chromosomes is fourteen.

4. In this as in all other plants the chromosomes show a difference in size. In *Tropaeolum* this difference is small and occurs without regularity. No theoretical importance is attached to the difference in size of the chromosomes.

5. Following the second mitosis the four granddaughter nuclei arrange themselves tetrahedrally near the periphery of the mother cell, and the connecting fibers soon fade away.

6. Ephemeral cell plates are formed, but they seem to have no function, and soon disappear.

7. The first indication of cell division usually occurs immediately after the tetrad nuclei are formed, although it may begin earlier. The cytoplasm constricts by means of broad hour-glass-like furrows, which cut the mass into four microspores. The constriction is produced by the plasma membrane.

8. A special callose wall is formed around the tetrad, but does not grow in between the young pollen grains.

9. A pale staining matrix, probably dissolved tapetum material, surrounds the young grains for some time.

10. A wall is formed around each individual pollen spore. The mother cell wall and special wall break down, liberating the spores.

The writer wishes to express her appreciation to Dr. D. M. Mottier, under whose direction the work was carried on, and to whom she is greatly indebted for advice and criticism.

BLOOMINGTON, INDIANA

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Explanation of plates 6, 7

All figures pertain to *Tropaeolum majus* L. They are camera drawings from microtome sections, drawn to the same scale.

Fig. 1. Pollen mother cell, showing nucleus in the resting stage. Several chromatin granules are to be found upon the thin linin threads.

Fig. 2. First contraction. Contents of nucleus massed into a dense knot at one side of the nuclear cavity.

Fig. 3. Coming out of first contraction. Spireme is becoming visible.

Fig. 4. Hollow spireme; thick chromatin thread evenly distributed within the nuclear cavity.

Fig. 5. Second contraction, in which the threads are massed into a central tangle, with loops extending out into the nuclear cavity.

Fig. 6. Bivalent chromosomes are formed, after the transverse segmentation, by the approximation in pairs of the univalents. At first they are irregular in size and shape, and assume a position near the nuclear membrane.

Fig. 7. Older stage than that represented by fig. 6. Some of the bivalent chromosomes are forming open or closed rings by the joining end to end of two univalent chromosomes.

Fig. 8. Beginning of anaphase. Members of the bivalent chromosomes separating, one-half going to one pole and the other to the opposite pole.

Fig. 9. Polar view of metaphase, showing fourteen haploid chromosomes.

Fig. 10. Pollen mother cell at the end of the heterotypic division, showing daughter nuclei with temporary cell plate.

Fig. 11. Stage similar to fig. 10, in which the cell plate has disappeared.

PLATE 7

Fig. 12. Homoeotypic spindles, lying with their axes at right angles to each other.

Fig. 13. Metaphase of homoeotypic division; spindles have their axes parallel to each other, and lie in the same plane.

Fig. 14. Anaphase of second division.

Fig. 15. Telophase of second division. Chromosomes form indefinite masses, when they first reach the poles. Slight constriction of the cytoplasm is beginning at points midway between the masses of chromosomes.

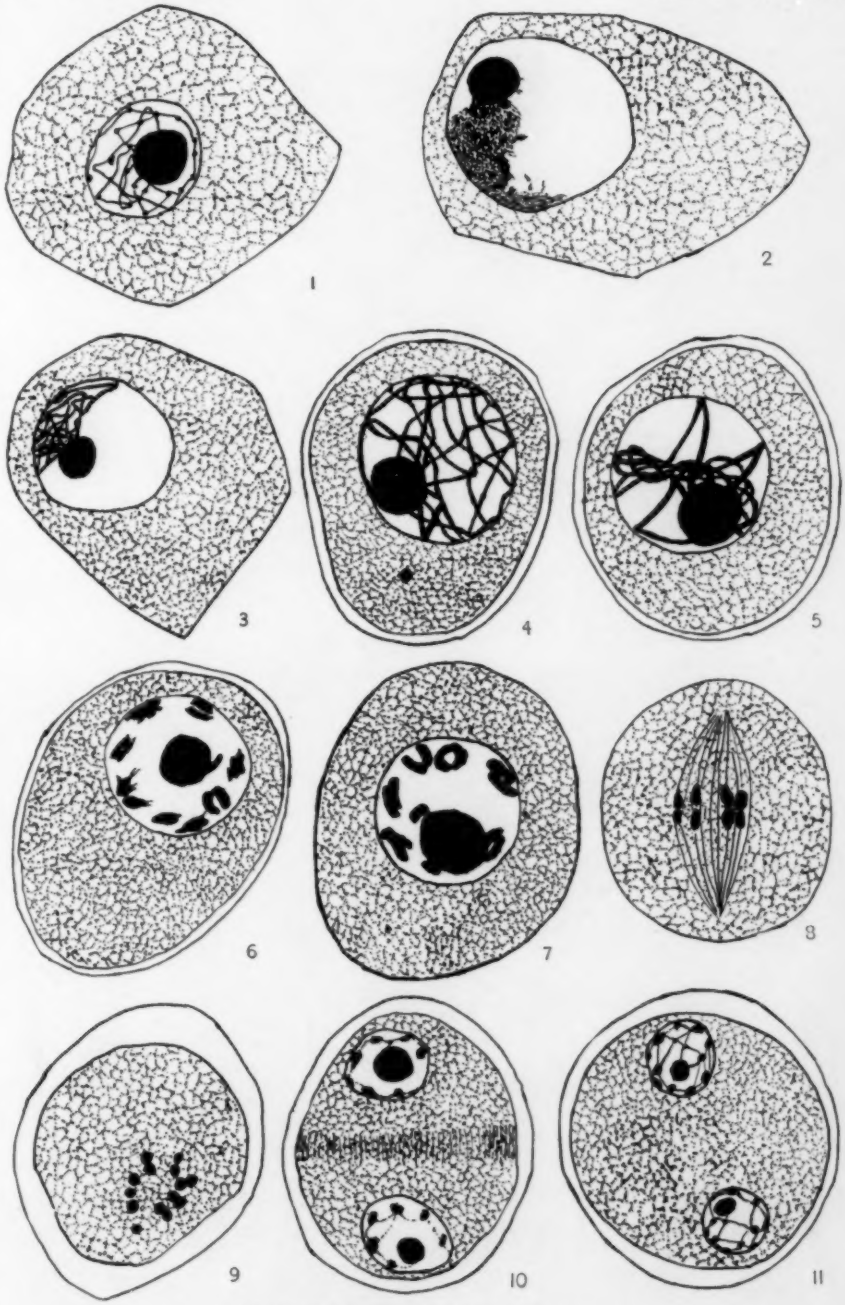
Fig. 16. Early stage in the formation of the tetrad. Chromosomes have become separated, and nuclear membrane is formed. A few connecting fibers and a temporary cell plate are still visible.

Fig. 17. Division of tetrad showing triangular space in center. Nucleolus has reappeared, and the nuclei take positions nearer the center of the future cells.

Fig. 18. Hourglass-like constriction, showing that tetrad division is nearly completed. One pair of granddaughter nuclei is visible, and by proper focusing the second pair comes into view. The latter are represented by dotted lines.

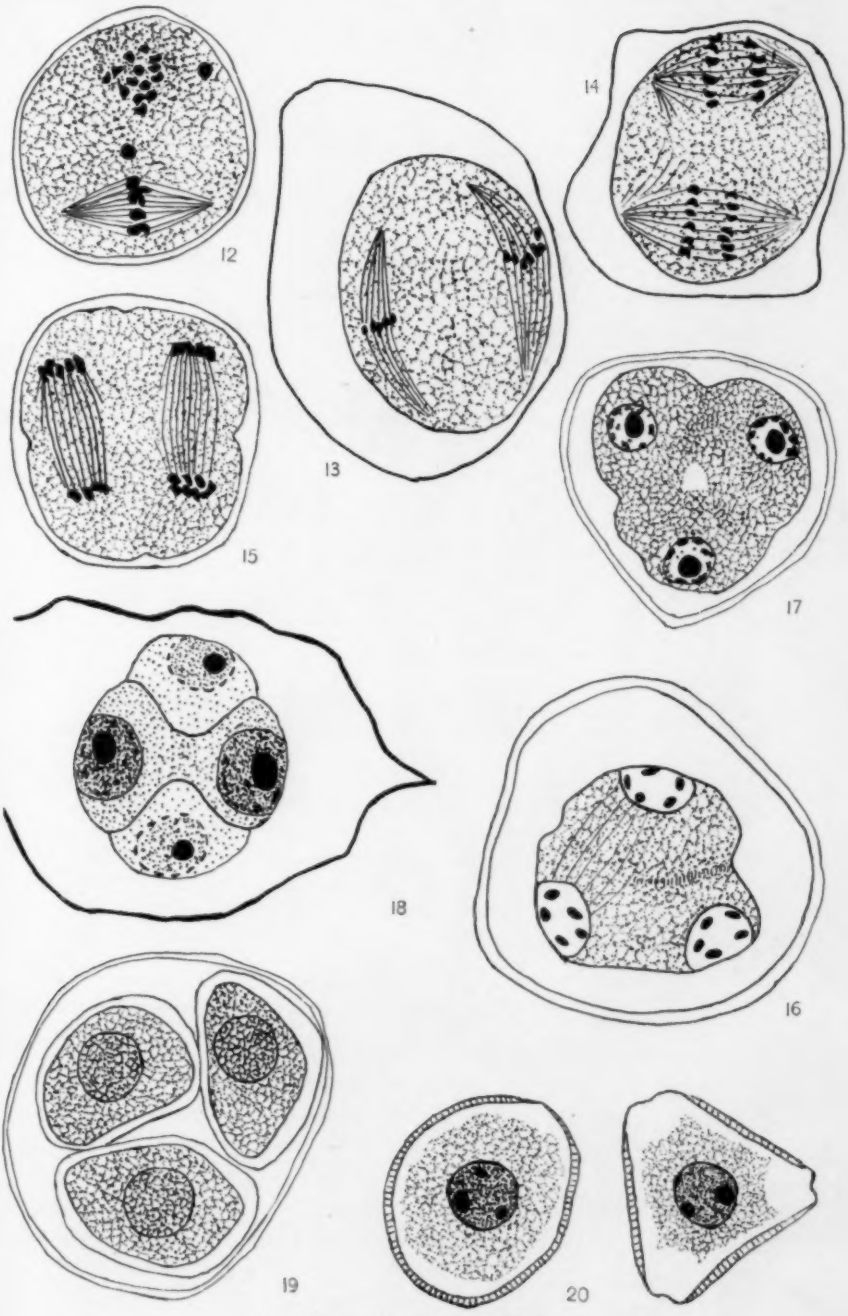
Fig. 19. Pollen spores with their individual walls. The grains are surrounded by a pale staining material, and the mother wall is still in place.

Fig. 20. One-celled pollen spores as they appear after the mother cell wall and special wall have broken down.



MICROSPOROGENESIS IN TROPAEOLUM

UNIV. OF MICH.



MICROSPOROGENESIS IN TROPAEOLUM

UNIV. OF MICH.

Miconia minutiflora and allied species

H. A. Gleason

The geographical range of the species aggregate usually known as *Miconia minutiflora* (Bonpl.) DC. has been steadily extended during the past century until it reaches from Mexico and Cuba on the north to Bolivia on the south. Examination of abundant material from the northern part of this range shows at once that three distinct species are represented, obviously closely related but apparently without intergrading forms. The distinctions between them are shown in the following key.

Sepals (calyx-lobes) short, not exceeding 0.3 mm. in length; external teeth none or less than 0.1 mm. long; hypanthium glabrous or nearly so; stamens barely dimorphic, the lateral lobes of the connective of the smaller not salient or none, those of the larger small or none.

Sepals depressed-triangular with concave sides, acute or subacute, the intervening sinuses broad, shallow, and rounded. ..... *M. minutiflora*

Sepals depressed semicircular, rounded and often minutely fimbriate at the tip, the intervening sinuses narrow and often acute at base ..... *M. borealis*

Sepals (calyx-lobes) triangular, acute, 0.5–0.7 mm. long, with nearly straight sides, with subulate external teeth about 0.3 mm. long, the intervening sinuses narrow and acute; hypanthium conspicuously stellate-pubescent; stamens distinctly dimorphic, the connective of the smaller with narrow dorsal lobe and prominently salient lateral lobes, that of the larger with lateral lobes directed forward. ..... *M. micrantha*

MICONIA MINUTIFLORA (Bonpl.) DC. Prodr. **3**: 189. 1828.

Melastoma minutiflora Bonpl. Melast. 50. *pl. 22*. 1809.
Glossocentrum collinum Crueger, Linnaea **20**: 111. 1847.
Miconia glossocentra Naud. Ann. Sci. Nat. Bot. III. **16**: 243. 1851.
Miconia myriantha Griseb. Fl. Brit. W. Ind. 257. 1864. Not *M. myriantha* Benth.

The type locality is Cumana, Venezuela, where it was collected at an altitude of about 3000 feet. It is distributed through northern South America from Colombia to Trinidad, usually at altitudes of from 1500 to 5000 feet.

Miconia borealis n. sp.

Cremanium rubens Griseb. Cat. Pl. Cub. 103. 1866. Not *C. rubens* DC.

Miconia minutiflora of various authors, especially Hemsley, Biol. Cent. Amer. 1: 427. 1880.

Nearly or quite glabrous throughout; stems terete or subterete; petioles 8–10 mm. long; leaf-blades firm, brownish green when dried, lanceolate, mostly 8–10 cm. long by 2–2.5 cm. broad, caudate-acuminate, entire or minutely denticulate, broadly acute at base, 3-nerved with a faint additional marginal pair, inflorescence freely branched, many-flowered, broadly pyramidal, 5–10 cm. long, the branchlets sharply 4-angled; pedicels less than 1 mm. long; flowers 5-merous; hypanthium broadly campanulate, 1.6 mm. long; sepals depressed semicircular, 0.25 mm. long, 0.6–0.8 mm. wide, external teeth none; anthers of section *Glossocentrum*, about 2 mm. long, the connective prolonged basally into a single dorsal lobe; style clavate, truncate.

Type, *Nelson 3294*, collected between Teneapa and Yajalon, Chiapas, 13 Oct. 1895 and deposited in the herbarium of the New York Botanical Garden.

Distribution, Central America, Mexico as far north as Vera Cruz, and western Cuba. *Wright 2517*, cited by Grisebach, belongs to this species.

MICONIA MYRIANTHA Benth. Hook. Jour. Bot. **2**: 314. 1840.

? *Cremanium trinitatis* Crueger, Linnaea **20**: 111. 1847.

? *Miconia trinitatis* Naud. Ann. Sci. Nat. Bot. III. **16**: 246. 1851.

Miconia minutiflora of various authors, especially Triana, Trans. Linn. Soc. Bot. **28**: 118. 1871.

This species is very common in British Guiana, whence it is represented by *Schomburgk 507* (type) and numerous later specimens, and extends to Surinam and French Guiana on the east. Westward it occurs in Trinidad, where it grows in low savanna country (*Broadway 10,175*), in contrast to the mountain habitat of *M. minutiflora*, and it is to be expected in the eastern part of Venezuela, although it was not collected there by Rusby & Squires or Broadway.

THE NEW YORK BOTANICAL GARDEN

Notes on Fabaceae—X

PER AXEL RYDBERG

ATELOPHRAGMA Rydberg

The genus was established in 1906 (Bull. Torrey Club **32**: 660) and based on six species of *Astragalus*. Of these *A. aboriginum* was regarded as the type. The most distinctive diagnostic characters of the genus are found in the pod, which is papery or membranous in texture, more or less elongate, usually distinctly stipitate, and with a partial septum formed by the inflexion of the lower suture. It corresponds to the section of the true Oroboidei of *Astragalus* of Gray's and Watson's revisions. Sheldon extended this section and brought in many new elements, i. e. species which have no close relationship with the original ones. The genus also comprises the sections Alpini and Strigulosi of Jones' revision. In two of our species, the lower suture is decidedly sulcate. One of these, *Astragalus alpinus*, I had included in the genus *Tium* just on this account, but the papery texture of the pod indicates a closer relationship with *A. oroboides* and its relatives; the structure of the pod otherwise is practically the same, so also that of the flower. In most of the Mexican species, the pod is also slightly sulcate on the lower suture.

KEY TO THE SECTIONS

Pod not sulcate on the lower suture, both sutures usually prominent.
- Pod distinctly stipitate.
  - Pod compressed, glabrous or minutely grayish-strigillose..... 1. GLABRIUSCULA
  - Pod more turgid, more or less black-hairy or in one species densely gray-pubescent..... 2. ROBBINSIANA
- Pod subsessile, turgid, the stipe less than 2 mm. long. 3. OROBOIDEA

Pod sulcate on the lower suture.
- Pod erect or ascending on short pedicels, sessile..... 5. WILLIAMSIANA
- Pod pendent on slender pedicels, stipitate.
  - Upper suture of the pod acute, straight or nearly so. 4. ALPINA
  - Upper suture blunt or rounded, both sutures nearly equally convexly curved.
    - Flowers more than 6 mm. long; racemes elongate at least in fruit; pod more than 1 cm. long..... 6. STRIGULOSA
    - Flowers less than 5 mm. long; racemes dense and short; pod less than 1 cm. long..... 7. SEATONIANA

1. GLABRIUSCULA

Leaves loosely and densely villous on both sides.
  Body of the pod obliquely oblanceolate, the stipe exceeding the calyx; racemes in anthesis dense, shorter than the peduncle: corolla white or ochroleucous, only the keel purplish..... 1. *A. aboriginum*
  Body of the pod elliptic, the stipe about equalling the calyx; racemes lax, about as long as the peduncle; corolla greenish-white, tinged with purple..... 2. *A. Cottoni*
Leaves strigose or glabrate or with scattered hairs.
  Leaflets elliptic or lance-elliptic.
    Leaves glabrous or with a few scattered hairs; corolla with purple-tipped keel..... 3. *A. Forwoodii*
    Leaves rather densely strigose beneath, glabrous above; corolla purple..... 4. *A. wallowense*
  Leaflets linear or lance-linear.
    Leaves glabrous or nearly so..... 5. *A. glabriusculum*
    Leaves rather densely strigose, at least beneath.
      Pod glabrous..... 6. *A. lineare*
      Pod strigose..... 7. *A. Herriotii*

1. ATELOPHRAGMA ABORIGINUM (Richards.) Rydb. This was originally described as *Astragalus aboriginorum* by Richardson in his *Appendix to Franklin's Journey*. Sprengel (followed by Torrey & Gray) changed the specific name to *aboriginum*, as the original form was grammatically incorrect. In the original diagnosis, the plant is described as being softly canescent and having linear or oblong leaflets and hairy pod. Hooker in his *Flora* presented a fuller description of his own, giving the pod as glabrous at maturity. One specimen of Richardson's collection in the herbarium of the Geological and Natural History Survey of Canada has a mature pod, which does not show any pubescence. Gray modified the description somewhat, giving the pubescence as '*Canescenti puberulus seu villosulus*.' In Richardson's plant the stem and leaves are white-villous, the leaflets linear, and the pod pubescent. Jones reduced *Astragalus glabriusculus* and *A. Forwoodii* to a variety of *A. aboriginum*. There are good reasons for such a view, for they are all very closely related. If these species are held as distinct, several others must be admitted, and *A. aboriginum* in such a case must be restricted. The typical form, agreeing with Richardson's description and specimens, is apparently very rare. Representative specimens have been collected between Lake Winnipeg and Bear Lake, *Richardson;* Rocky Mountains and Saskatchewan, *Bourgeau*.

In the Rocky Mountain region of the United States the pod is apparently glabrous from the beginning. This form might be distinct, but there is scarcely any other difference than the pubescence of the pod. It extends from Montana to the Black Hills of South Dakota, Colorado, and Nevada.

In the Yukon and Mackenzie territories there is found a similar variety but with narrowly linear leaflets, glabrous fruited and smaller flowers.

YUKON: White Horse Rapids, *Tarleton 34a; Kuscha;* Miles Cañon, *R. S. Williams*, in 1898.—MACKENZIE: Bernard Harbour, *F. Johansen 310.*

Richardson, in his report on the collection made on Franklin's first journey, listed *Astragalus vaginatus* Pall., without any description or remarks. Hooker in his *Flora Boreali-Americana* took up this name, and gave a short description and compared it with *A. aboriginum* Richardson, stating that it has larger flowers. Through the kindness of the Director of the British Museum we have received a photograph of Richardson's plant which looks astonishingly like a specimen of *A. aboriginum* with narrow leaflets. The description calls for a pubescent plant, and the photograph indicates a pubescence similar to that of *A. aboriginum*. The photograph looks like the Alaska specimens mentioned above with narrow leaflets, but evidently had larger flowers. As far as the type locality is concerned, Richardson denoted it by (*B*) which meant Barren Grounds, Hooker gave it as 'Woody Country between lat. 54° and 64° N.' Sheldon substituted the name *A. Richardsonii* for *A. vaginatus* Richardson, not Pall. Both names become synonyms of *Atelophragma aboriginum*.

2. **Atelophragma Cottoni** (M. E. Jones) Rydb. *Astragalus Cottoni* M. E. Jones, Rev. Astragalus 135. 1923. In habit this closely resembles the preceeding, but is usually more decumbent. The distinctions given by Jones in his key, separating it from *A. aboriginum*, do not hold, partly because Jones evidently had committed some error in reading proof (the same characters given to both), and partly because the latter is wrongly described. The most striking difference is in the pod, which in *A. Cottoni* is much broader, fully 1 cm. broad, and almost equally curved on the lower as on the upper suture; in the related species the pod is almost straight on the lower suture.

It was first described as *A. olympicus* Cotton, a name which is preoccupied.

WASHINGTON: Challan, *Elmer 2531.*

3. ATELOPHRAGMA FORWOODII (S. Wats.) Rydb. *Astragalus Forwoodii* was described by Watson as being annual, belonging to the section *Homalobus*, and related to *A. stenophyllus*. The relationship is without doubt with *A. aboriginum* and *A. glabriusculum*. Jones (Rev. Astragalus 135. 1923) included it in the latter, which he regarded as a variety of the former, stating however that it is an 'intermediate form.' It differs from the former in the appressed pubescence, from the latter in the more pubescent foliage, and from both in the broader leaflets. *Astragalus glabriusculus major* A. Gray represents a luxuriant form, less pubescent than usually. This varietal name was changed by Sheldon to *spatiosus*. Heller raised it to specific rank under the name *Astragalus spatiosus*.

Astragalus aboriginum fastigiosum M. E. Jones, as to the type, represents a depauperate alpine form.

SOUTH DAKOTA: Black Hills, *Rydberg 623; Carr 45, Forwood; Over 1865.*—MONTANA: Beaver Head County, *Tweedy 205;* Belt River, *F. W. Anderson 1793;* Mt. Higgin, *Jones;* Appekunny, *Standley 15290;* Electric Peak, *Mearns 236.*—WYOMING: Big Horn Mountains, *Tweedy 135; 3162;* Table Mountain *A. Nelson 55;* Cheyenne River, *T. A. Williams;* Ferris Mountain, *E. Nelson 4968.*—COLORADO: *Hall & Harbour 116; Parry 1864; Wolf & Rothrock 249.*—NEW MEXICO: *Parry 55.*

4. **Atelophragma wallowense** Rydb. sp. nov. Perennial, with a woody root and cespitose caudex; stems decumbent, terete, sparingly strigose, 1–2 dm. high; leaves 2–4 cm. long; stipules ovate or oblong, 4–5 mm. long, leaflets 9–13, lance-oblong, acute at each end, strigose beneath, sparingly so or glabrate above, 8–15 mm. long, 2–3 mm. wide; peduncles 3–7 cm. long; raceme short and dense at first, in age elongate; bracts oblong, 2–3 mm. long; pedicels short; calyx black-villous, the tube 3 mm. long, the teeth subulate, 2 mm. long; corolla tinged with blue-purple, the keel tipped with dark-purple; banner obovate, slightly shorter, the blade oblong, decidedly falcate; keel-petals broad, the blade broadly lunate, rounded at the apex; pod glabrous, the stipe 5 mm. long, the body semi-oblanceolate or slightly falcate, about 15 mm. long, 4–5 mm. broad, arched on the upper, nearly straight on the lower suture.

The type was collected on the Wallowa Mountains, Oregon, July 28, 1899, *Cusick 2267* (Gray Herbarium). This is closely related to *A. Forwoodii* but differs in the bluish purple corolla and the leaflets, which are densely pubescent beneath and glabrous above. The type was originally determined as *Astragalus aboriginum*, and Jones included it in his variety *fastigiorum*. The type of the latter, however, belongs to *A. Forwoodii*.

5. ATELOPHRAGMA GLABRIUSCULUM (Hook) Rydb. The type of *Phaca glabriuscula* was collected by Drummond in the Canadian Rockies, and is closely related to *A. Forwoodii*, differing mainly in the very narrow leaflets.

ALBERTA: *Drummond:* Morley, *Macoun*, in 1885; Basin, and Bow River Valley, *S. Brown 68;* Tunnel Mountain, *McCalla 2132;* Banff, *Moodie 1246.*—MONTANA: Midway, *Nelson & Nelson 5456.*—SOUTH DAKOTA: Box Elder Creek, Black Hills, *W. S. Rusby*, in 1887.—WYOMING: *Parry 71.*

6. ATELOPHRAGMA LINEARE Rydberg. This resembles *A. aboriginum* and *A. glabriusculum* in habit and leaf-form, but differs from the former in the strigose, not villous, pubescence and from the latter in the leaves, which are strigose on both sides, densely so beneath.

YUKON: Lake Lebarge, *Tarleton 34b;* Dry Gulch, *Gorman 1014;* Whitehorse, *J. P. Anderson 1768; Alice Eastwood 625; Tarleton 34a.*—MACKENZIE: West Shore of Great Bear Lake, *Bell 22899.*

7. **Atelophragma Herriotii** Rydb. sp. nov. Perennial, with a cespitose caudex; stems 2–3 dm. high, erect or decumbent at the base, finely strigose; leaves ascending, 5–7 cm. long; stipules deltoid or lanceolate, 3–4 mm. long; leaflets 7–11, linear, 1.5–2.5 cm. long, 1.5–3 mm. wide, densely strigose beneath, sparingly so or glabrous above; peduncles 5–10 cm. long, erect; racemes at first short, elongate in age, 8–15-flowered; bracts subulate, 4–5 mm. long; pedicels about 2 mm. long; calyx black-hairy, the tube 2.5–3 mm. long, the teeth subulate, 1.5 mm. long; corolla cream-colored, 8–9 mm. long, the keel tipped with purple; banner obovate, strongly arched, wings shorter, the blade oblong, falcate, with a rounded basal auricle; keel-petals still shorter, the blade broadly semi-obovate, strongly falcate, rounded at the apex; pod strigulose at least when young, the stipe four mm. long, the body broadly semi-oblanceolate, about 15 mm. long, 2 mm. wide; the upper suture arched, the lower nearly straight.

It is closely related to the preceeding, differing mainly in the smaller strigose pod; the leaflets are glabrous above and often broader than in that species.

MANITOBA: Qu' Appelle River, *Macoun & Herriot 70479; Herriott*, in 1906; *Macoun*, in 1879.—ALBERTA: Bow Valley, *Marion Moodie 48* (?).

2. ROBBINSIANA

Corolla white; body of the pod abruptly contracted at each end, minutely and sparingly black-hairy..... 8. *A. Robbinsii*

Corolla purplish; pod gradually tapering at each end, or at least at the base; pod densely hairy.

Leaflets glabrous or nearly so on both sides..... 9. *A. Jesupi*

Leaflets distinctly strigose or pilose beneath.

Corolla about 1 cm. long; leaflets strigose or strigulose beneath.

Stipe decidedly longer than the calyx-tube..... 10. *A. Blakei*

Stipe about as long as the calyx-tube or slightly shorter.

Calyx and pod black-hairy; calyx teeth about 1 mm. long; leaflets glabrous above, sparingly strigose beneath..... 11. *A. Macounii*

Calyx and pod with white hairs; calyx-teeth 1.5–2 mm. long; leaflets sparingly pubescent above, densely so beneath..... 12. *A. Fernaldi*

Corolla about 12–15 mm. long.

Stipe slightly if at all exceeding the calyx-tube; leaves canescent-pilose beneath, at least when young..... 13. *A. Harringtonii*

Stipe equaling or exceeding the calyx-teeth, leaves sparingly pilose beneath..... 14. *A. Collieri*

8. **Atelophragma Robbinsii** (Oakes) Rydberg. *Phaca Robbinsii* Oakes, Hovey's Mag. **7**: 181. 1841. This was the first known species of the group, and at the same time one of the rarest, having been collected apparently only at one station, at which place it is now extinct. It differs from the related species in the white corolla, the short finely strigulose pod, which tapers more abruptly especially at the distal end. The stipe barely exceeds the calyx-tube; the leaflets are glabrous above, sparingly strigulose beneath. Dr. Gray transferred it to the genus *Astragalus* and Jones has reduced it to a variety of *A. labradoricus*, which latter species he has misunderstood. The species is apparently now extinct. (See Torreya **24**: 98–101.)

VERMONT: Winooski River, near Burlington, *Robbins*, in

1829; *Oakes*, in 1841; *Carey*, in 1841; *Pringle*, in 1875–1878; *Brainerd*, in 1878; *Grout*, in 1891; *Jones & Eggleston*, in 1893.

9. **Atelophragma Jesupi** (Eggleston & Sheldon) Rydb. *Astragalus Robbinsii Jesupi* Eggleston & Sheldon, Minn. Bot. Stud. **1**: 115. 1894. This is closely related to the preceeding, but is larger, with dark-purple corolla, larger pod, more gradually tapering at both ends, with a longer stipe; the leaflets are glabrous or nearly so on both sides. Britton raised it to specific rank under the name of *Astragalus Jesupi*. Robinson and Fernald united it with the next species. Jones has followed the latter authors but went further, including also *A. Macounii* Rydberg, first under the name *Astragalus occidentalis*, but later under *A. labradoricus*. *A. labradoricus* DC. was based on *A. secundus* Michx., which name was untenable. There is in the Torrey Herbarium a fragment of Michaux' type, and the pod with the very fine and sparse pubescence shows that it is the same as *Astragalus alpinus Brunetianus* Fernald, and neither *A. Blakei* nor *A. Jesupi*. The distribution of *A. Jesupi* is along the Connecticut River Valley on both sides of the river.

VERMONT: Hartland, *Eggleston*, in 1894 and 1896; *176*, in 1898.—NEW HAMPSHIRE: Hanover, Summers Falls, Plainfield, *Jesup; Eggleston*.

10. **Atelophragma Blakei** (Eggleston) Rydb. *Astragalus Blakei* Eggleston Bot. Gaz. **20**: 271. 1895. This species was first distributed under the name *Astragalus Robbinsii borealis* and originally described as having sulcate pod. Evidently the pod is not sulcate under ordinary circumstances and scarcely to be distinguished from that of the preceeding species, though the stipe may be slightly longer. The main differences between the two species are in the leaves, which are decidedly strigose beneath, and in the corollas which are usually somewhat smaller and paler, approaching that of *A. Robbinsii*. Eggleston in the original publication included in it specimens from the Rocky Mountains and Alaska, but these evidently belong to *A. Macounii*.

VERMONT: Smuggler's Notch, Mt. Mansfield, *Eggleston*, in 1894 and 1897; *1949*, and *1950*, in 1900; *Brainerd*, in 1878 and 1896; *Miss E. G. Knight*, in 1884; *Grout*, in 1895; *Brainerd*, in 1878; *Pringle*, in 1878; *Morong*, in 1878; *Greenman, 969; Church-*

hill, in 1897; Willoughby Mountains, *Weatherby, 3684; Annie Lorenz*, in 1917; *Blake*, in 1857; *Pringle*, in 1881; *Eggleston & Grant*, in 1894; *Rusby*, in 1892; *E. F. Williams, Faxon, Blake;* Mt. Hor, *Faxon, Blake.*—MAINE: St. John's River, *Miss Furbish.*—LABRADOR: *S. R. Butler.*

11. ATELOPHRAGMA MACOUNII Rydb. This is closely related to the preceeding, but differs in the short stipe, scarcely exceeding the calyx tube, and by the smaller corolla. The first collection mentioned of this plant was specimens collected by Bourgeau in the Canadian Rockies; these were referred to *A. Robbinsii occidentalis* by Watson with some doubt in King's Report. Similar specimens collected in Colorado were referred the same way by Brandegee and by Jones. Jones for some time regarded *A. Macounii* and *A. occidentalis* (Watson) Heller as the same but in his *Revision* he refers the former to his *A. labradoricus*, 'intergrading toward the var. occidentalis.' It is common in the Rocky Mountains, from Alberta and British Columbia to Colorado and Idaho.

12. **Atelophragma Fernaldi** Rydberg, sp. nov. Perennial, with a stout root and cespitose subterranean caudex; stems about 3 dm. high, angled, sparingly strigose, more or less purplish; leaves 4–6 cm. long; stipules deltoid, about 5 mm. long; leaflets 9–13, oblong or elliptic, 1.5–2 cm. long, 4–6 mm. wide, sparingly hairy above, grayish-strigose beneath, rounded at each end; peduncles 5–7 cm. long; raceme 3–6 cm. long; bracts linear-lanceolate, 3 mm. long; calyx white-strigose, the tube 3 mm. long, the teeth lance-subulate, 1.5–2 mm. long; corolla purple, about 1 cm. long; banner broadly obovate, moderately arcuate; wings shorter, the blades oblong, falcate; keel-petals still shorter, the blades rounded at the apex; pod whitish or grayish-strigose, the stipe slightly shorter than the calyx-tube, the body oblanceolate in outline, acute at each end, about 1.5 cm. long.

The type was collected at Blanc Sablon, Labrador, Aug. 6, 1910, *Fernald 3632* (herb. N. Y. Bot. Gard.). It was originally determined as *Astragalus eucosmus* Robins., which is the same as *Atelophragma elegans* (Hook.) Rydb., but differs in the longer, more acute pod, the larger flower, and in the leaflets which are sparingly pubescent above. The pod is more like that of *A. Macounii*, which is not found in the East, belonging to the Rocky Mountain Region.

13. **Atelophragma Harringtonii** (Cov. & Standl.) Rydb. sp.

nov. *Astragalus Harringtonii* Cov. & Standl. Ms. in herb. Perennial with a rootstock; stems decumbent at the base, 2–3 dm. high, angled, sparingly pubescent with black ascending hairs; leaves 6–10 cm. long; stipules broadly ovate, 5–8 mm. long, leaflets 11–15, elliptic or oval, 1–2 cm. long, 5–10 mm. wide, sparingly pilose but soon glabrate above, rather densely white-pilose beneath, at least when young; peduncles 6–10 cm. long, black-hairy; bracts linear-subulate, 9–5 mm. long; calyx black-hairy, the tube 5 mm. long, 2.5–3 mm. broad, the teeth 3–4 mm. long, subulate; corolla purplish, 12–15 mm. long; banner obovate, strongly arched at the middle, deeply retuse at the apex; wings nearly as long, the blade oblanceolate with a large reflexed auricle; keel-petals much shorter, the blades obliquely obovate, rounded at the apex; pod black-hairy, the stipe about equalling the calyx-tube; the body lance-elliptic, acute at each end, 10–12 mm. long, 4–5 mm. broad, the sutures nearly equally curved, the lower sulcate, the partial septum about 1 mm. wide; seeds dark-brown, orbicular-reniform, fully 2 mm. broad.

This differs from the rest of the American species in the larger flowers and the dense pubescence of the lower surface of the leaves.

ALASKA: Limestone ridge, Goodnews Bay, *Harrington 60* (type, U. S. Nat. Herb. *989332*, flower), also at Matanuska, July 20, 1922, *J. P. Anderson, 1787* (fruit, herb. N. Y. Bot. Gard.); Yakutat, *Mr. & Mrs. E. P. Walker, 1058* (in flowers); Glacier Bay, *J. P. Anderson, 1261* (?, more glabrate in old fruit); Kobuls River, *L. J. Palmer, 658* (labeled *A. Funstoni* Wight); John River, *Schrader*, in 1901; Pyramid Harbor, *Th. Meehan*, in 1883.

14. **Atelophragma Collieri** Rydb. sp. nov. A perennial; stems 3–6 dm. high, somewhat angled, glabrous or nearly so, branched; leaves nearly sessile, about 1 dm. long, the rachis glabrous; stipules lanceolate, 5 mm. long, green; leaflets 11–15, elliptic, 1.5–3 cm. long, 5–10 mm. wide, glabrous and dark-green above, paler and sparingly pilose beneath, rounded or retuse at the apex; peduncles 10–15 cm. long, angled; racemes 5–15 cm. long, the rachis sparingly black-hairy; bracts subulate, 3 mm. long; pedicels about 3 mm. long; calyx black-hairy, the tube 3 mm. long, oblique above, the teeth subulate, 1.5 mm. long; corolla apparently white, 12 mm. long or more, banner obovate, retuse at the apex, strongly arcuate; wings slightly shorter, the blades oblanceolate; keel-petals shorter, the blade broadly lunate, rounded at the apex; pod membranous, black-hairy, the stipe 5 mm. long or more, the body fully 2 cm. long, 6–7 mm. high, acute at each end, the cross-section elliptic, the partial septum fully 1 mm. wide.

Type collected at Eagle, Alaska, June 29, 1902. *A. C. Collier 50* (U. S. Nat. Herb. no. 379736). It is related to *A. Harringtonii*, but is taller, the leaves not canescent beneath and the stipe much longer and the pod more acute. Besides the type a specimen from Glazier Bay, *Anderson 1264*, and another from Yukon Valley, *Funston 67*, are to be referred to it.

3. OROBOIDEA

Pod hairy; leaflets not retuse.
  Leaflets thin oblong to oval; plant erect; raceme many-flowered.
    Pod about 1.5 cm. long, gradually acute..... 15. *A. occidentale*
    Pod about 1 cm. long or less, rather abruptly acute.
      Leaflets elliptic or oblong, hairy at least above... 16. *A. elegans*
      Leaflets rounded-oval to orbicular, glabrous..... 17. *A. alpiniforme*
  Leaflets linear; plant decumbent; raceme few-flowered. 18. *A. Brandegei*
Pod glabrous, reticulate; leaflets thick, retuse..... 19. *A. Shearii*

15. **Atelophragma occidentale** (S. Wats.) Rydb. *Astragalus Robbinsii occidentalis* S. Wats. Bot. King. Exp. 70. 1871. This was originally described from poor depauperate specimens, and Watson's description is also inadequate. Jones (Contr. W. Bot. **8**: 17. 1898) raised it first to specific rank, and pointed out its similarity to and differences from *A. elegans* and *A. Robbinsii*. The closer relationship is without doubt with *A. elegans* and *A. Macounii*. Later Jones in his *Revision* made it a variety of *Astragalus labradoricus* DC., which species he had misunderstood. His interpretation of that species consisted of a mixture of *A. Blakei*, *A. Jesupi* and *A. Macounii*. Jones gives the range of *A. occidentale* as East Humboldt Mountains, Nevada to the Blue Mountains, Oregon and northward and eastward to Colorado. I think it is limited to the East Humboldt Mountains only; the Colorado specimens belong to *A. Macounii*, and probably also the Oregon ones.

NEVADA: East Humboldt Mountains; *Watson 268; Jones*, in 1897 and 1901; Lamville Creek, Elks Co., *Heller 9281*.

16. ATELOPHRAGMA ELEGANS (Hook.) Rydb. *Phaca elegans* was described from specimens collected in the Canadian Rocky Mountains. Gray regarded it as a variety of *Astragalus oroboides* of Europe, but it is distinct enough from that species. Sheldon adopted the name *Astragalus elegans*, although there was an older *A. elegans* Bunge. B. L. Robinson therefore,

changed the name to *A. eucosmus*, a name overlooked by Jones. The specific name *elegans* is, however, available in *Atelophragma*, if not in *Astragalus*. The range of the species extends from Labrador and Maine to British Columbia and Alaska and in the Rocky Mountains south to Colorado.

The following eastern specimens have been seen:

LABRADOR: Long Point, *Waghorne, 4306;* Rome, *Stecker, 363.*—QUEBEC: Bonaventure County, *Collins, Fernald & Pease*, in 1904. Montane River, *J. A. Allen*, in 1881; River Sainte Anne des Monts, *Macoun, 498.*—UNGAVA: Fort Chimo, Ungava River, *Spreadborough, 16298.*—NEWFOUNDLAND: Grand Falls, *Fernald & Wiegand, 5795, 5797;* Pilot Bay, *Fernald, Wiegand & Long, 28591, 28594.*—MAINE: Mapleton, *Williams, Collins & Fernald, 5795.*

17. **Atelophragma alpiniforme** Rydb. sp. nov. A perennial, with a cespitose rootstock; stems several, slender, erect, 2–3 dm. high, glabrous; leaves 5–7 cm. long, ascending or spreading; stipules ovate or suborbicular, more or less clasping, 3–4 mm. long, the lower scarious; leaflets 11–15, rounded-oval or suborbicular, 5–10 mm. long, 3–8 mm. wide, glabrous on both sides; peduncles 6–10 mm. long, erect; racemes 2–3 cm. long, in fruit 5–7 cm. long; bracts ovate, 1–2 mm. long; calyx sparingly black-hairy, the tube 3 mm. long, the teeth lanceolate, 1 mm. long; corolla bluish-purple, 8 mm. long; banner broadly obovate, retuse at the apex; wings somewhat shorter, the blade oblong, slightly falcate; keel-petals still shorter, the blade obovate-lunate, rounded at the strongly arched summit; pod black-hairy, with short hairs, obovoid, inflated, 10–12 mm. long, 6–7 mm. wide, the stipe about 15 mm. long.

In habit the plant resembles most *A. alpinum*, but the pod is short-hairy, not sulcate, resembling that of *A. elegans* in shape, though the stipe is slightly longer. It may also be compared with *A. Robbinsi;* the pod has the same short pubescence, but it is convex on both sutures and the corolla purple. In *A. Robbinsii* the pod is nearly straight or even slightly concave on the upper suture and more pointed, and the corolla white. The type was collected on bars of Hurricane Creek, Wallowa Mountains, Oregon, August 25, 1898, *Cusick 2103* (type in Gray Herbarium).

18. ATELOPHRAGMA BRANDEGEI (Porter) Rydberg. Though the general habit of this species is very different, the structure of

its pod is practically the same as in *A. elegans* and *A. occidentale.* Jones in his revision placed it between *Astragalus strigulosus* H.B.K. of Mexico and *A. platytropus* A. Gray. The former has a stipitate pod, sulcate on the lower suture, the latter is a true *Cystium* with bladdery 2-celled pod. It is not related to either.

COLORADO: Pleasant Valley, *Brandegee*, in 1877; *Eastwood* in 1889; San Juan, *Eastwood, 27;* Denver, *Eastwood.*—NEW MEXICO: Fort Wingate, *Matthews;* Santa Fé, *Heller*, in 1897.—ARIZONA: Fort Apache, *Hoyt*, in 1893; Banghart's Ranch, *Rusby, 572; 108*, in 1883.—UTAH: Emory, *Jones, 5445c;* Tropic, *5307;* Loa, *5649f; Ward.*

19. ATELOPHRAGMA SHEARII Rydb. Jones in his *Revision*, reduced this to a synonym of *Astragalus elegans.* Probably he had seen no specimens. *A. Shearii* is so unlike that species that nobody knowing it would think that they are the same. In habit it is more like *Astragalus flexuosus* and *A. Hallii.* Its pod is perfectly glabrous, slightly curved, reticulate and quite unlike the pods of this section of *Atelophragma.* As it has a distinct partial septum and is membranous, the plant is therefore placed in this genus. It is known only from Twin Lakes, Colorado.

4. ALPINA

Pod densely long-pubescent, straight or nearly so; calyx densely black-hairy	20. *A. alpinum*
Pod sparingly short-strigulose, more or less arcuate, *i.e.* even the upper suture curved upwards; calyx tube nearly glabrous	21. *A. labradoricum*

20. **Atelophragma alpinum** (L.) Rydb. *Astragalus alpinus* L. Sp. Pl. 760. 1753. This is the most widely distributed of our species, its range extending through the boreal, mountain, and subarctic regions of America, Europe and Asia. It is very variable as to the size of the plant and the shape of the leaflets. The original form, most common in Europe, is a low plant with decumbent stems and broad leaflets. The same form is also found in the Arctic and Alpine regions in North America. The extreme depauperate form was described by Nuttall as *Astragalus andinus*, a name which was taken up by Jones, who followed Sheldon in using the name *A. alpinus* for *Phaca alpina* L.

He states (Rev. Astrag. 137. 1923) 'The necessity for adopting the *Phaca alpina* L. for *A. frigidus* L., because of the Vienna rules, requires renaming the *Astragalus alpinus* L.' The Vienna rule abridged reads as follows: 'When a species is moved into another genus the first specific epithet must be retained unless in the new position there exists one of the obstacles indicated in the articles of section 7.' In section 7 we read: 'Everyone should refuse to admit a name in the following cases: . . . 2. When it duplicates the name of . . . a species of the same genus.' According to these rules *Phaca alpina* L. should retain its specific name if transferred to *Astragalus* unless it duplicates an *Astragalus alpinus*, which it would do. There is therefore no reason for changing the name of *A. alpinus* L.

On the other hand, Piper, who used *Phaca* L. for *Astragalus* L., the former having page priority, made the combination *Phaca alpina* (L.) Piper for *Astragalus alpinus* L. Sheldon also mistook the more luxuriant form of the subalpine mountains for *A. alpinus giganteus* Pallas, and proposed the name *A. giganteus* for this form, although there was already an *A. giganteus* S. Wats.

In North America *Atelophragma alpinum* ranges from Greenland to Alaska, and south to the mountains of New England, and in the Rockies to New Mexico. It is found in the Blue Mountains of Oregon and Ruby Mountains of Nevada, but is evidently lacking in the Sierra Nevada and the Cascade Mountains. On account of the sulcate pod I have erroneously referred this species to *Tium*.

21. **Atelophragma labradoricum** (D.C.) Rydb. *Astragalus labradoricus* D.C. Prod. 2: 287. 1825. This species was based on *A. secundus* Michx., which name was untenable. What this species really was has been the object of many wild guesses. Most botanists have regarded it as a synonym of *Astragalus alpinus* L. Some of the eastern botanists have regarded it as the same as *A. Robbinsii*, others as *A. Blakei*. Jones adopted the name *A. labradoricus* for an aggregate of *A. Blakei*, *A. Jesupi*, and *A. Macounii*, making *A. Robinsii* and *A. occidentalis* varieties. Fortunately there is in the Torrey Herbarium a pod from Michaux' collection and this evidently belongs to *Astragalus alpinus Brunetianus* Fernald. This is unquestionably closely related to *A. alpinus* L., and those botanists who regarded *A. labradoricus* as a form or variety of *A. alpinus* were not far

off. Jones' dictum without supporting facts, was, to say the least, rather rash.

Jones (Contr. W. Bot. 8: 5. 1898) makes also the following statement: 'Micheli, the original collector, considered it only a form of *A. alpinus*.' Michaux, not Micheli, was the author and he made no such statement. The following specimens belong here.

LABRADOR: *Waghorn 19*:—NEW BRUNSWICK: Grand Falls, *Northrop 44;* Upper Queenbury, *Fernald & Pease 25170*.—NEWFOUNDLAND: Grand Falls, *Fernald & Wiegand 5793, 5794*.—QUEBEC: *Michaux;* L'Islet, *Victorin 3193;* St. Laurent de l'Isle d'Orleans, *16119;* Cape Rouge, *16118*.—MAINE: Fort Fairfield, *Fernald 24;* Coast, *Blake*, in 1864; Fort Kent, *Eggleston 3028; Mackenzie 3383;* Seven Islands, *St. John & Nichols 2361*.—NEW HAMPSHIRE: Summer's Fall, Plainfield, *Eggleston*, in 1894; *Jesup*, in 1877 and 1891.—VERMONT: Barnet, *Alice Sterne* 1886–9; *Blanchard* in 1884.

5. WILLIAMSIANA

22. **Atelophragma Williamsii** Rydb. *Astragalus Williamsii* Rydb. Bull. N. Y. Bot. Gard. **2**: 175. 1901. This species resembles *Phaca frigida* L. in habit and flower, but the pod is quite different, being subsessile and with a distinct though partial septum. It also resembles the European *Atelophragma oroboides* (Hornem.) Rydb. (*Astragalus oroboides* Horneman), but the pod is erect and the flowers ochroleucous. Jones published the same species under the name *Astragalus Gormani* Wight. He has omitted *A. Williamsii* in his *Revision* except in the index, where he gives the place of publication without reference to page or his number of the species.

YUKON: Big Salmon, *R. S. Williams* (type); Five-finger Rapids, *Tarleton, 92a, 92b;* Fort Selkirk, *Gorman 1092* (type of *A. Gormani*); Carmacks, *J. P. Anderson 1778*.—ALASKA: Rampart, *Mrs. Rader 66;* John River, *Schrader*, in 1901; 50-mile River, *Bolton*, in 1899.

INDEX TO AMERICAN BOTANICAL LITERATURE
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